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INVESTIGATION OF ELASTOSIL M4370 SILICONE RUBBER RELEASE AGENT FOR USE ON M1130 PROJECTILE

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14. ABSTRACT

An investigation of two release agents [Miller Stevenson's MS-143DF Polytetrafluoroethylene (PTFE) Release Agent - Dry Lubricant and Vaseline 100% Pure Petroleum Jelly] to create a separation in the room temperature vulcanizing (RTV) above the interface of the explosive and RTV to prevent the cracking of the explosive below the interface with the RTV. Test specimens were fabricated and subjected to various environmental conditions to determine if the RTV will remain separate or adhere to itself thus causing cracks and voids in the explosive below the interface.

15. SUBJECT TERMS

Elastosil® M4370 silicone rubber; Polytetrafluoroethylene (PTFE); Petroleum jelly
MS-143DF PTFE release agent; M1130 projectile

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INTRODUCTION

During temperature cycling of the M1130 projectiles, cracks and voids developed in the explosive right below the explosive/ room temperature vulcanizing (RTV) interface, which could affect the functioning of the projectile. On the M1130 projectile, explosive is poured into the cavity of the projectile leaving a gap between the explosive and the fuze. A two part RTV silicone rubber, Walker Silicones RTV4370 (RTV) with primer G790 is used to fill the void at the top of the projectile. The primer is applied to the explosive to adhere the RTV to the explosive. The adhesion of the RTV to the explosive is required to ensure that there is no gap between the explosive and RTV. The Organic Materials Technology Branch; Energetics, Warheads and Manufacturing Technology Directorate; U.S. Army Armaments Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey was requested to investigate the use of two release agents [Miller Stevenson's MS-143DF Polytetrafluoro-ethylene (PTFE) Release Agent - Dry Lubricant and Vaseline 100% Pure Petroleum Jelly) to create a separation in the RTV above the interface of the explosive and RTV to prevent the cracking of the explosive below the interface with the RTV. Test specimens were fabricated and subjected to various environmental conditions to determine if the RTV will remain separate or adhere to itself thus causing cracks and voids in the explosive below the interface. This report details the results of this study.

MATERIALS

Walker Silicone ELASTOSIL® M4370 A/B silicone rubber, RTV

Miller Stevenson's MS-143DF PTFE Release Agent - Dry Lubricant (MS-143DF)

Vaseline 100% pure petroleum jelly

The Buckeye Stamping Company - seamless tin boxes, style 201, 4 oz

TEST PROCEDURE

Fabrication of Test Specimens

Seamless tin boxes were selected to simulate the projectile cavity and enable the RTV to be tested on a instrumented tensile tester. The bottoms of the tin boxes were centered drilled with a ¼-in. hole and a ¼-in. bolt assembled through the hole to be used during testing of the specimens. The bolts were used to fasten the can to the tensile tester.

The boxes were then cleaned with acetone prior to pouring an 1.8-in. layer of RTV in the boxes. The RTV was allowed to cure overnight.

The two release agents (MS-143DF and petroleum jelly) were applied to the cured RTV and the walls of the boxes (half the boxes receiving each release agent).

There were 2-in. discs cut from G10/FR4 epoxy panel, 1/16-in. thick, with a ¼-in. by 3-in. bolt placed through a hole in the center of the disc. The disc assembly was placed in the center of the boxes with the bolt with approximately an 1/8-in. space between cured RTV and the disc for RTV to flow around the disc. Photographs of the test specimen disc assemblies are shown in figure 1.

Figure 1
Disc assembly

A second layer of RTV approximately ¼-in. thick, was poured into the boxes and allowed to cure. Photographs of the fabricated boxes are shown in figure 2.

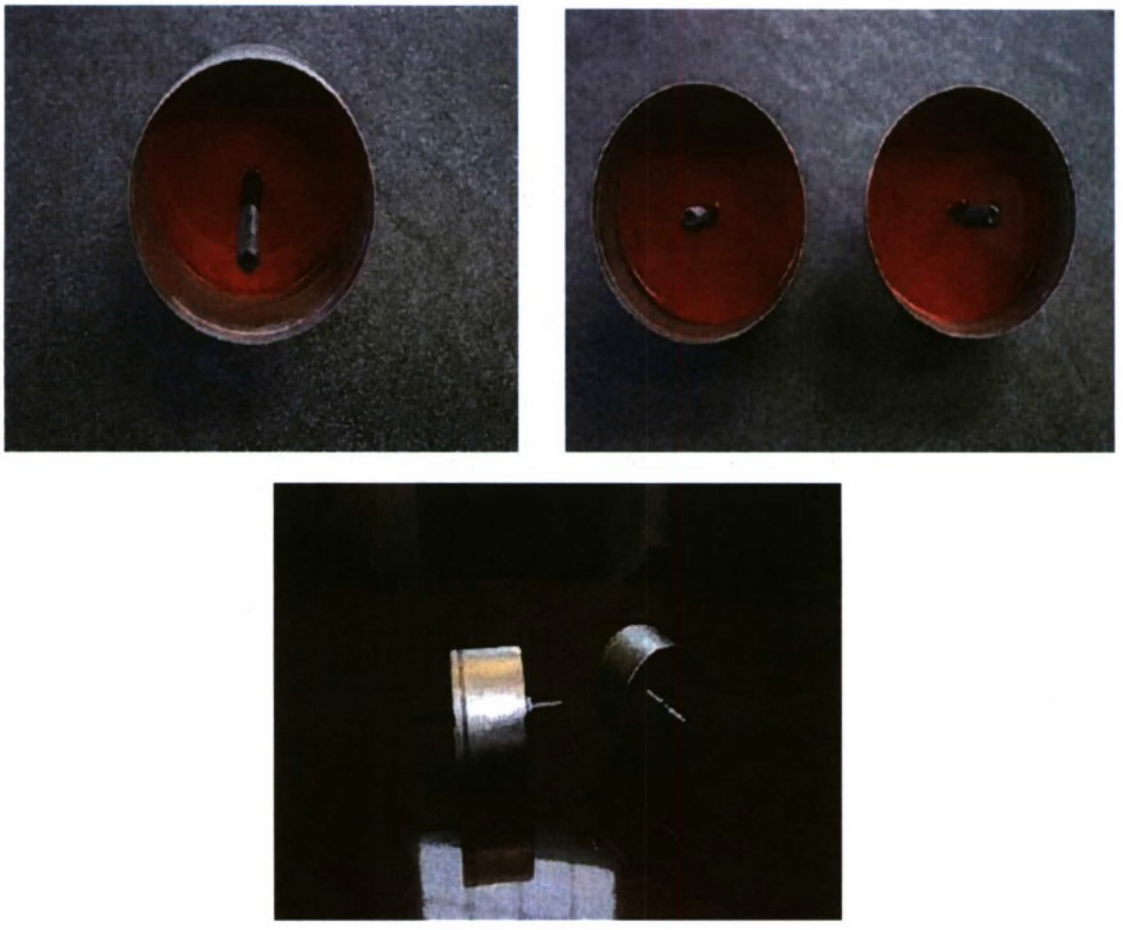

Figure 2
Boxes after fabrication

The boxes were placed in various environments (+160°F, thermal cycle between -50°F and +145°F and room temperature) for 4 wks. Each week to boxes (specimens) were withdrawn and tested on the Instron tensile tester. The boxes were tested in tension at a crosshead rate of 0.2 in./min and a chart speed of 0.5 in./min. Figure 3 contains photographs of the test setup.

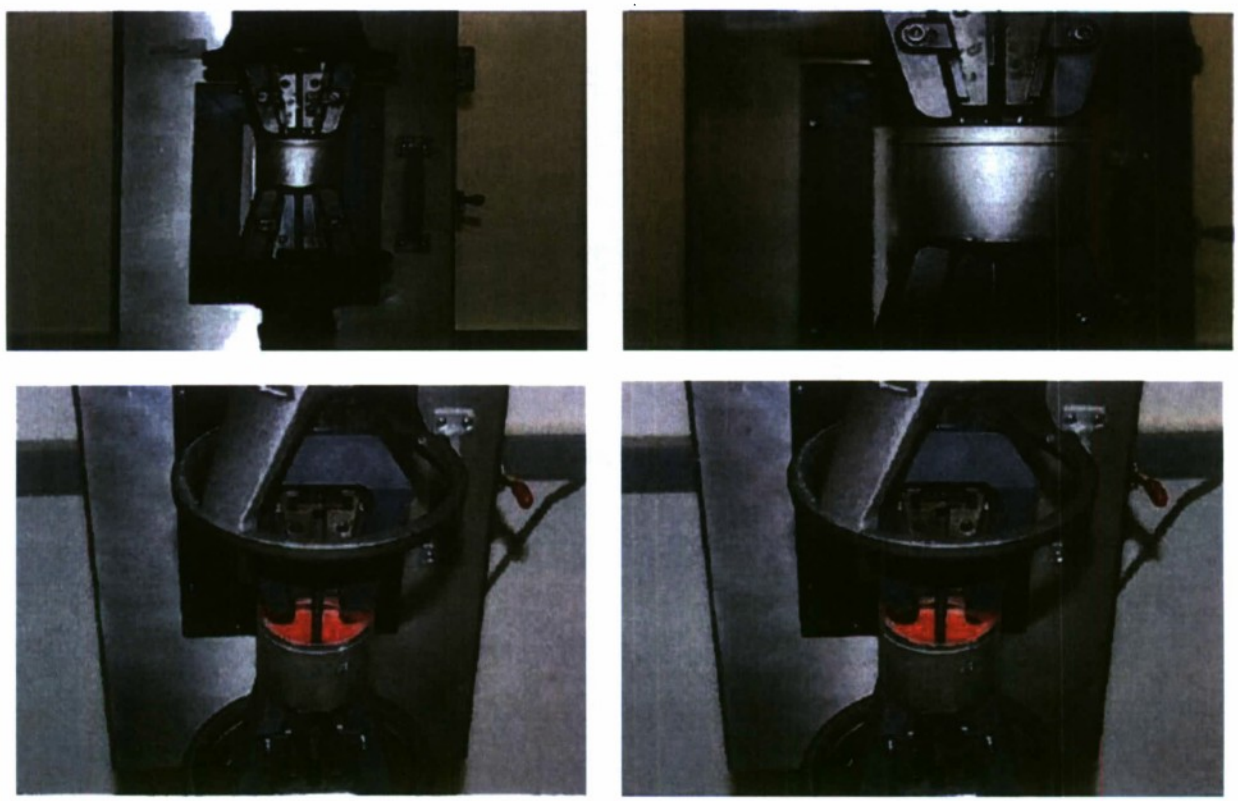

Figure 3
Test setup

Figure 4 is a photograph of the boxes after testing.

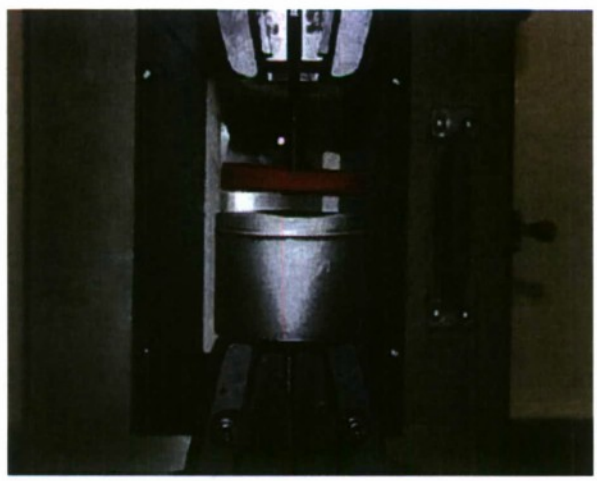

Figure 4
Boxes after testing - RTV removed

After testing, the boxes were reassembled by hand. They were allowed to sit for 24 hrs and retested to obtain the pull force required to disassemble the can with the top layer of RTV placed on the bottom layer.

RESULTS

The boxes were withdrawn from environmental conditioning and tested 24 hrs after withdrawal. The summary of the test data is shown in table 1.

Table 1

		PTFE		Petroleum jelly	
		Pull force (lb)	Re-pull force (lb)	Pull force (lb)	Re-pull force (lb)
Initial		50.42	8.46	46.56	11.74
Week 1	Room temp	63.5	8.0	58.0	11.6
	Thermal cycle	58.5	11.0	64.5	13.25
	160°F	41.5	2.0	55.0	19.15
Week 2	Room temp	54.0	22.5	55.0	19.15
	Thermal cycle	38.0	3.5	69.3	7.9
	160°F	39.0	19.2	53.6	13.45
Week 3	Room temp	61.0	22.5	70.05	10.0
	Thermal cycle	11.75	2.5	67.85	15.2
	160°F	67.85	8.25	37.25	18.5
Week 4	Room temp	55.76	17.75	55.25	19.0
	Thermal cycle	38.25	10.5	61.0	14.85
	160°F	55.0	11.5	31.25	8.75

The actual test data are listed in tables 2 and 3 (PTFE in table 2 and petroleum jelly in table 3). The aged samples were limited (two for each condition), and therefore the data is widely scattered in some cases, which was the two mold releases have similar results.

Table 2
PTFE test data

Initial	1	2	3	4	5	Average
Pull	61.5	27.0	57.5	52.3	53.8	50.42
Re-pull	11.0	3.5	6.8	3.0	18.0	8.46

Week 1	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	65.0	62.0	63.5	4.0	19.0	8.0
Thermal cycle	47.5	69.5	58.5	1.0	21.0	11.0
160°F	25.0	58.0	41.5	3.0	1.0	2.0

Week 2	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	49.0	59.0	54.0	12.0	33.0	22.5
Thermal cycle	70.0	6.0	38.0	1.0	6.0	3.5
160°F	66.0	12.0	39.0	0.5	37.8	19.2

Table 2
(continued)

Week 3	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	52.0	70.0	61.0	36.0	14.5	22.5
Thermal cycle	5.0	18.5	11.8	2.0	3.0	2.5
160°F	64.5	71.2	67.9	12.5	4.0	8.3

Week 4	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	39.5	72.0	55.8	16.0	19.5	17.8
Thermal cycle	5.0	71.5	38.3	9.2	11.8	10.5
160°F	37.0	73.0	55.0	13.0	10.0	11.5

Table 3
Petroleum jelly test data

Initial	1	2	3	4	5	Average
Pull	58.5	9.3	50.0	61.0	54.0	46.56
Re-pull	14.0	4.2	2.0	37.0	1.5	11.74

Week 1	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	67.5	50.0	58.8	18.0	5.0	11.6
Thermal cycle	69.5	59.5	64.5	11.8	14.7	13.3
160°F	58.0	52.0	55.0	38.0	1.0	19.2

Week 2	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	68.5	70.0	69.3	7.3	8.5	7.9
Thermal cycle	59.7	47.5	53.6	26.2	0.7	13.5
160°F	64.0	34.0	49.0	16.0	4.0	10.0

Week 3	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	73.3	66.8	70.1	10.0	20.4	15.2
Thermal cycle	64.5	71.2	67.9	4.0	33.0	18.5
160°F	13.0	61.5	37.3	36.0	14.5	25.3

Week 4	Pull 1	Pull 2	Average	Re-pull 1	Re-pull 1	Average
Room temp	52.0	58.5	55.3	19.0	19.0	19.0
Thermal cycle	58.5	63.5	61.0	20.5	9.2	14.9
160°F	58.5	4.0	31.3	13.0	4.5	8.8

These data indicate that the pounds force load required to separate the two layers of RTV M4370 did not increase drastically after conditioning of the boxes. The initial test results were based on a sample of five boxes for both the PTFE and petroleum jelly with tensile pull range of 27 to 61.5 lb for the PTFE and 9.3 to 61 lb for the petroleum jelly. The range for the re-pull for the PTFE was 3 to 18 lb and for the petroleum jelly 2 to 37 lb. For the conditioned boxes, two samples were pulled for each condition. Figure 5 is photographs of the boxes after testing.

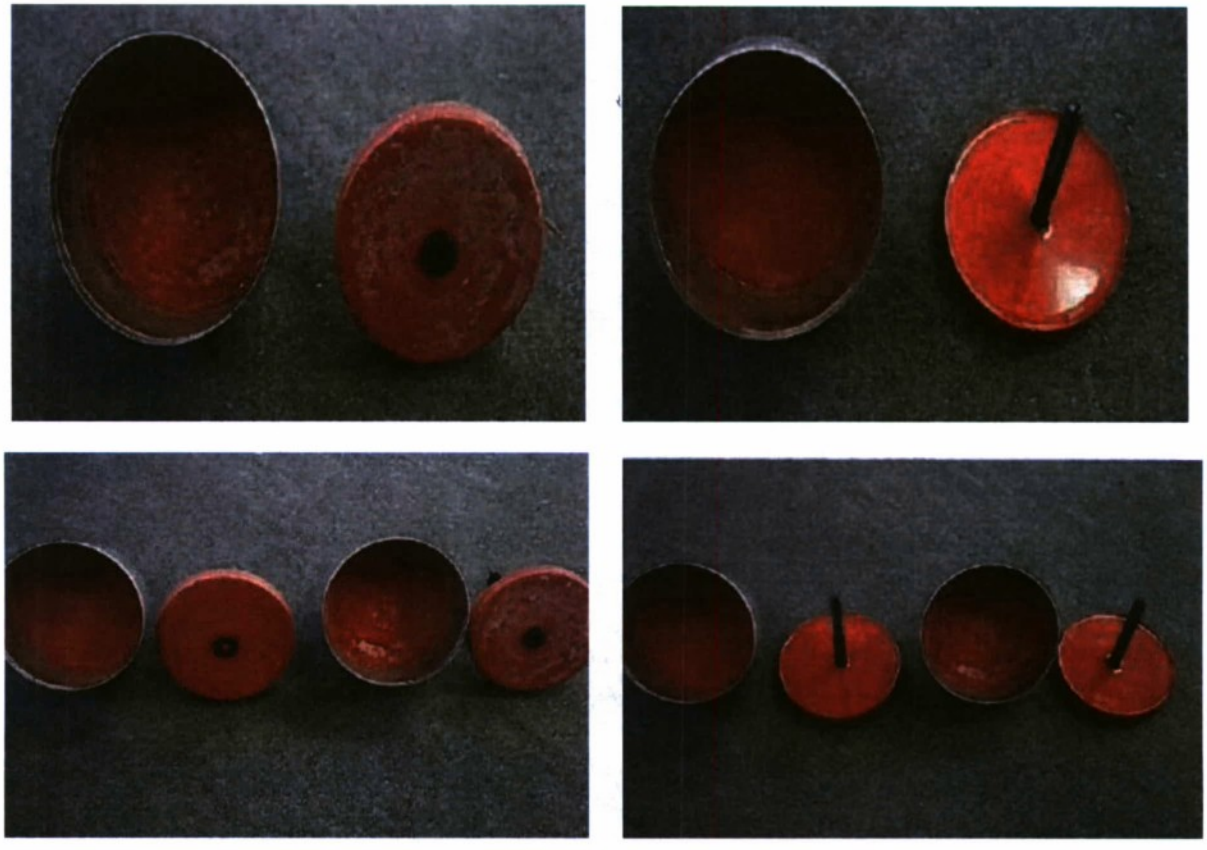

Figure 5
Box after testing

The averages of all the pulls were no higher than the highest value of the 61.5 lb for the initial controls for the PTFE except for the room temperature after 1 wk and 160°F after 3 wks. A review of the raw data indicates that several boxes had pulls over 61.5 lb after conditioning with the highest value of 73 lb. For the re-pull, the PTFE had several values over the high of 18 lb. In some cases, the average of the two pulls would represent a high value for one box and a low value for the other box; therefore, the average for the condition was within the range of the initial results. A possible explanation for one box being high with the second box low for boxes conditioned in the same environment for the same amount of time is that the conditioning chambers had slightly varying temperatures (hot and cold spots) and over time caused changes in the required force to separate the layers of RTV. The boxes were all fabricated at the same time and after fabrication, the boxes were randomly selected and placed in the various environments. This was also the case for the petroleum jelly boxes. The increase in the pull strength does not appear to indicate that the two layers of RTV would not separate over time causing cracking in the energetic material.

The data for the petroleum jelly shows that the average for several environments had averages over the high initial value of 61 lb. Specifically, thermal cycling after 1, 3, and 4 wks had higher averages as well as after 2 and 3 wks at room temperature. A review of the raw data indicates several high force data points exceeded the highest value for the controls of 61 lb, with the highest value of 73 lb, the same as PTFE. For the re-pull values, only one value at hot (160°F) after 1 wk was higher than the highest value of 37 lb for the initial value of 37 lb for the initial room temperature results. Again, the highest value of 38 lb had a box pull at 1 lb for an average of 19.5 lb for the re-pull for the 1 wk after the

160°F storage. Most of the averages for the petroleum jelly re-pulls were higher than the average for the initial controls.

From these data, the petroleum jelly has slightly better test results than the PTFE. However, due to the limited number of test specimens, both the PTFE and petroleum jelly appear to be adequate for mold release for the RTV M4370 separation of the layers. As indicated in figures 6 through 11, neither mold release caused a dramatic increase in the amount of force to separate the two layers of RTV. The desired effect was to either see a constant force over time or a decrease in the force required. An increase in the force required indicates a force required which could over time increase the chance of cracks developing in the energetic.

Figures 6 through 11 show the data verses time for the various environmental conditioning for initial pulls and re-pulls.

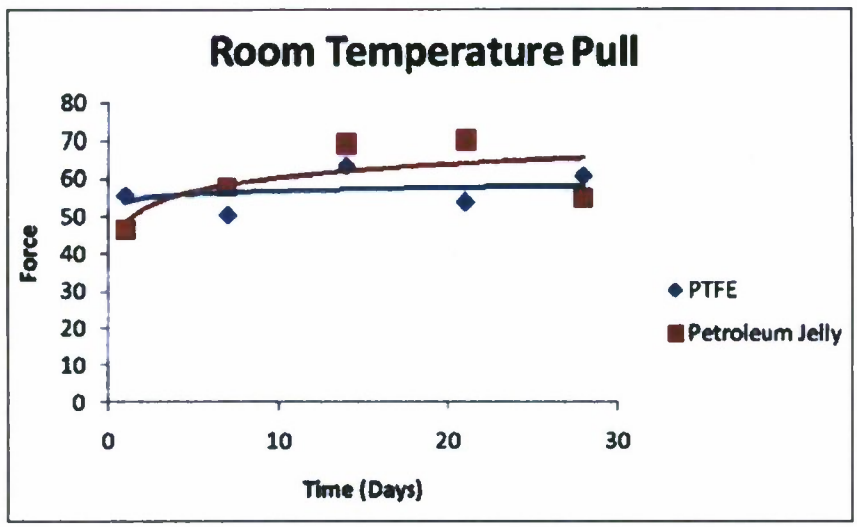

Figure 6
Room temperature initial pull

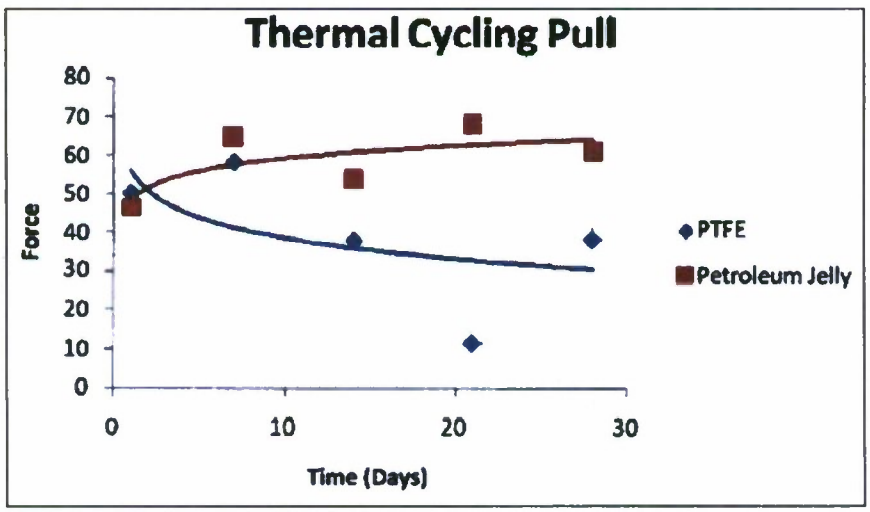

Figure 7
Thermal cycle initial pull

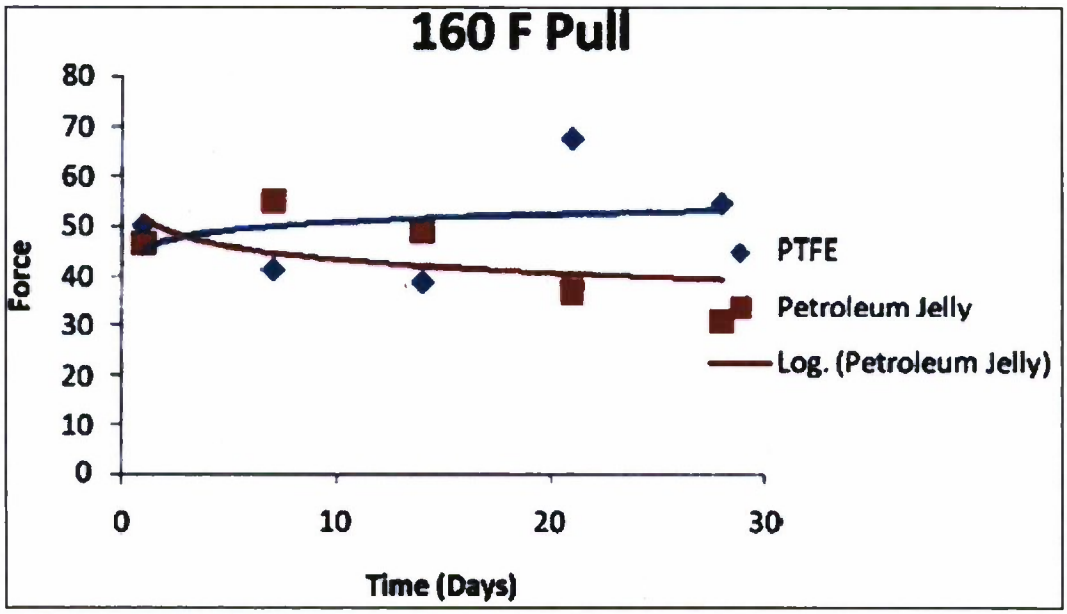

Figure 8
Hot (+160°F) initial pull

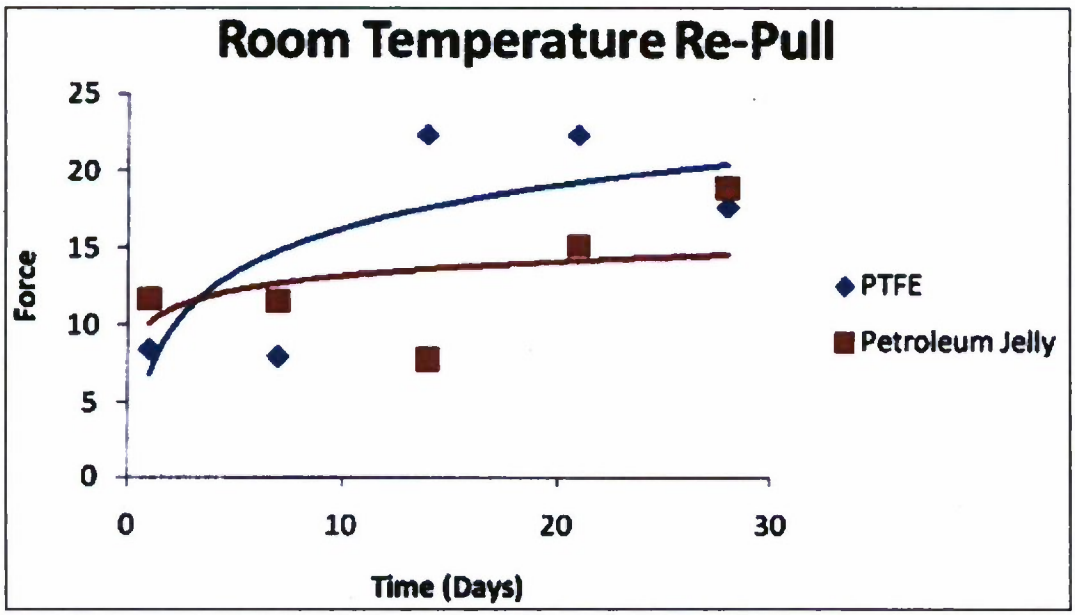

Figure 9
Room temperature re-pull

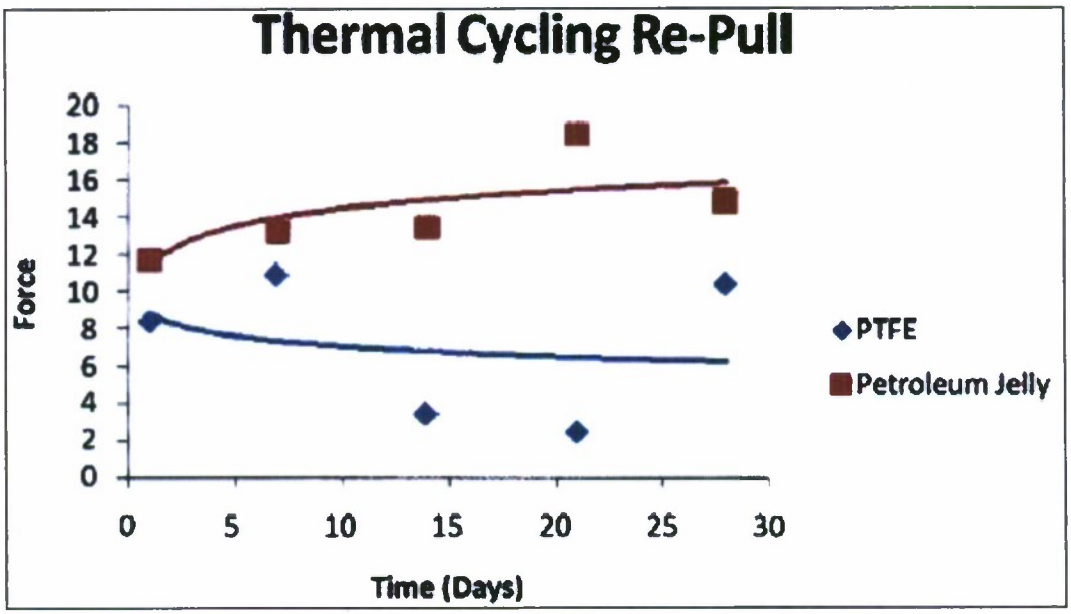

Figure 10
Thermal cycle re-pull

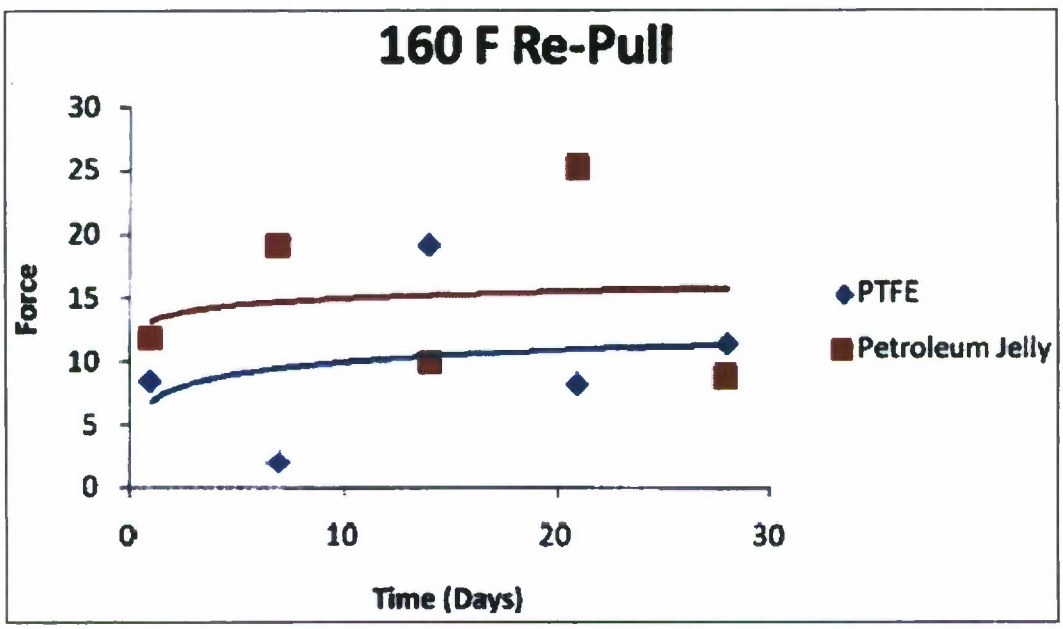

Figure 11
Hot (+160°F) initial re-pull

CONCLUSIONS

The polytetrafluoroethylene (PTFE) and petroleum jelly mold release are adequate candidates to use as mold releases between the two layers of Walker silicone ELASTOSIL® M4370 A/B silicone rubber, RTV.

RECOMMENDATIONS

Both polytetrafluoroethylene and petroleum jelly are suitable candidates as the mold release between the layers of Walker silicone ELASTOSIL® M 4370 A/B silicone rubber, RTV should be listed on the drawing.

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